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DEVELOPMENT OF A CFC CRITICAL AREA RESPONSE (CAR) PACKAGE

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ABSTRACT

During the past two years, the NASA Marshall Space Flight Center (MSFC) has studied means to improve the transfer of technology from a major federal lab to a significant portion of an industrial segment. In the past, technology transfers had taken place with individual firms, or small groups of firms. This method of "customized" transfer is often time consuming and can reduce the effectiveness of a response. Thus, a method was achieved to develop a standardized package on replacement of Chlorofluorocarbons (CFCs) that could be sent out to a large number of firms with minimum follow-up.

INTRODUCTION

The usual role of a technology transfer agent is to convey an existing technology from the originator to prospective users. This is typically accomplished by locating reports or other descriptions of the technology and then transferring them to the requesting entities. Often this process is aided by use of special seminars or workshops surrounding a particular technology. Also, brochures explaining the technology sources may be circulated for an increased effect. This paper describes a more proactive approach to technology transfer. In this approach, a technology transfer product was developed as a stand-alone method of transferring a very specific type of technology. At the NASA Marshall Space Flight Center (MSFC), this product is known as a Critical Area Response (CAR) package. This concept was developed to serve the technology transfer process in specific industry-critical areas where information is needed urgently.

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This may be considered a handbook or workbook approach to technology transfer. That is, a stand-alone, user-friendly data package is produced that should, in one operation, solve a majority of the user's needs for knowledge of a specific technology. In the case of mature technology, such a data package product would remain current for a considerable period. However, there are also urgent industrial needs for data packages in areas of major ongoing development such as CFC replacement.

BACKGROUND

The Criticality of CFC Replacement

The natural ozone umbrella that helps protect life on our earth from the harmful effects of ultraviolet (UV) radiation from the sun is being damaged by extensive use of chlorofluorocarbons (CFCs). The ozone layer of our atmosphere circles the earth performing two important functions. This pale blue gas, a variation in the oxygen molecule, is toxic if breathed but, in the stratosphere 10 to 30 miles above the surface of the earth, the layer acts as a filter to protect us from UV and as a "blanket" to stabilize earth's temperatures. Every 1-percent drop in ozone levels can lead to a 3-percent increase in non-melanoma skin cancers in light-skinned people, dramatic increases in blinding eye cataracts, lethal melanoma cancers, and damage to the human immune system. In addition, timber production sags and crop losses increase.

Stability of the ozone layer itself is fragile and is being adversely affected by man's use of CFCs in various industrial processes and in mechanical systems. CFC molecules that are vented or allowed to evaporate in these processes, make their way to the stratosphere where, when coming into contact with ozone, they act to deplete it from the air. **One** CFC-generated chlorine atom alone can catalyze the destruction of as many as **100,000** ozone molecules.

The effects of a CFC molecule on ozone has been demonstrated in the laboratory as well as by computer modeling.

The depletion process, shown in Figure 1, is as follows:

1-2. A CFC molecule uses its chlorine atom to break down an ozone atom into an oxygen atom. An ozone molecule is lost in the process;

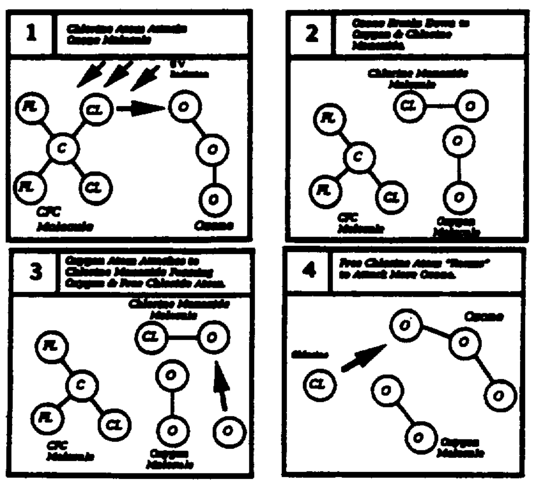

Figure 1 - Ozone Depletion By CFCs

3. Another chlorine atom is freed;

4. The new chlorine eventually comes into contact with another ozone molecule, starting the process over.

Substantial Ozone depletion is the result of these interactions between CFCs and the atmosphere. Ozone levels have dropped an estimated 40 percent in certain spots over the last decade. At the South Pole (and the North Pole to a lesser extent) the depletion is severe enough that a measurable hole has appeared. It is estimated that over the next decade, stratospheric chlorine levels will continue to rise at a rate of about 5 percent per year. Today's level is 3.5 parts per billion, almost six times the normal "background" level .

In 1991, NASA launched the Space Shuttle Discovery carrying a 7 and one-half-ton satellite whose primary purpose is to learn more about the ozone depletion problem. This $700 million dollar investment shows the magnitude of importance placed upon Ozone depletion by NASA and the United States Government.

A world-wide effort is underway to control and limit the amount of CFC gases released into the atmosphere. The drive began in 1978 when the use of CFCs in aerosol cans were banned in the United States. In 1987 the first meeting of 23 major industrialized nations met in Montreal, Canada to address future plans for controlling CFCs. It was agreed that CFC production would be phased down to fifty percent of that year's level by 1998. According to Dow Chemical, the U. S. produced 1.7 billion pounds of chlorinated solvents in 1989.

In 1990, nations again met and agreed to accelerate the phase out schedule. The result of this London meeting was an agreement to totally ban CFC production by the year 2000. Then in February 1992, President George Bush announced that production of CFCs in the U. S. would be banned altogether after January 1, 1996. This accelerated schedule is shown in Figure 2.

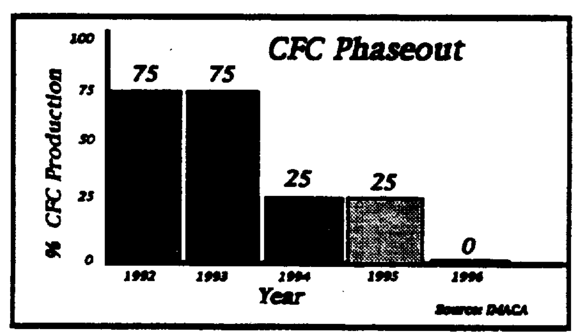

Figure 2 - U.S. CFC Phase out Schedule

Additional legislation has been passed in the U. S. to further control the release of CFCs. For instance, in 1990, the Federal Clean Air Act was amended to require the recapture and recycling of any refrigerant removed from automotive air conditioning (A/C) systems. The Act requires that all technicians handling CFC compounds must be properly trained and certified and imposed an excise tax on the purchase of new R-12 refrigerant (freon). As shown in Figure 3, the tax on a pound of CFC-12 for automotive use was $1.67 in 1992. By 1999, if CFCs were available, the tax would add $4.90 per pound to cost. Other aspects of industry are also affected. Cleaning operations that have previously used solvents such as 1, 1, 1 Trichloroethane, Freon, MEK, Acetone, and other potentially harmful solvents must be modified. Generation of foams requiring CFC blowing agents must be revisited and the CFC hazards curtailed. Table 1 shows a listing of common CFC compounds affected.

Table 1 - CFCs Ins and Outs [Source IMACA]

Compound	Lifetime (years)	Ozone Depletion Potential (avg.)	Global Warming	Primary Uses
What's Out				
CFC-11	60	1	1	Refrig., A/C, foams
CFC-12	120	1	3	Refrig., A/C, foams
CFC-113	90	0.8	1.4	Solvents
CFC-114	200	0.7	3.9	Foam packaging, aerosols
CFC-115	400	0.4	7.5	Refrigeration
What's In				
HCFC-22	15	0.05	0.34	Refrig., A/C, foams
HCFC-123	2	0.02	0.02	Refrig., foams, solvents
HCFC-124	7	0.02	0.1	A/C, insulating foams
HCFC-141b	8	0.1	0.09	Insulating foams, solvents
HCFC-142b	19	0.06	0.36	Insulating foams, solvents
HFC-125	28	0	0.58	Refrigeration
HFC-134a	16	0	0.26	Refrigeration, A/C
HFC-152a	2	0	0.03	Insulating foams, aerosols

The Basic MSFC Tech Transfer Approach

Generally, the technology transfer field does not think of its stock-in-trade (technical information) as a product or service in the way that is used in a manufacturing or technical services company. Marketing of a package of data like the CFC Critical Area Response is approached typically in a non-commercial manner. This situation is best seen in the "shotgun" approach to achieving technology transfer as is used at many federal laboratories. A typical "shopping list" of general technical areas of capability used by the NASA Marshall Space Flight Center (MSFC) describing each laboratory's primary capabilities is distributed. Other federal labs use similar lists. This information is widely circulated and results in a certain number of requests for technical assistance. However, the matching of technical capability to requestor needs is often difficult. Thus the capabilities of the "shopping list" are not targeted to a specific market.

At MSFC, technology assistance has been promoted for many years. The general approach has been to depend on the shopping list of technical expertise and hope that one or more technologies would appeal to significant numbers of a general audience.

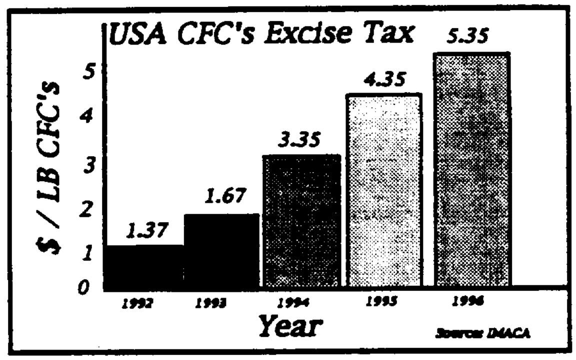

Figure 3 - Excise Taxes On CFC's

In addition, numerous technology transfer workshops or seminars have been held in Alabama and the Southeast to attract clientele. In recent years, these "road shows" have been improved by highlighting specific technology transfer projects or "success stories" to demonstrate the existence of successful transfers.

The ORNL Approach

Further justification of the CAR approach is noted at Oak Ridge National Laboratory (ORNL), where technology transfer has been handled by the operating contractor, Martin Marietta Energy Systems, for more than a dozen years. As an industrial firm, Martin Marietta took a more commercial approach to marketing ORNL technology than did typical federal labs such as MSFC. The ORNL approach was to hire seven full-time technology transfer personnel, most of whom had business degrees. This group then began to search the totality of the diverse ORNL technology base to locate a few new technologies deemed ready to begin the process of commercialization. Then the ORNL technology transfer (T^2) team began a market survey of possible firms that might be interested in commercializing each of the subject new ORNL technologies. Because these new technologies tended to be specific and esoteric, the market survey was very focused. This focused marketing approach has been rather successful at ORNL. A significant number of companies have signed agreements (CRADAs) for joint product or process development and a number of laboratory patents have been licensed.

Developing the CAR Package

Partly as a result of the success of focused technology transfer marketing at ORNL, the MSFC Technology Utilization Office (TUO) with the assistance of the University of Alabama in Huntsville (UAH) developed the concept of a basic technology transfer product (stand-alone data package). The product, a Critical Area Response (CAR) package, is developed to respond to a known critical area of technology transfer need. Critical technology transfer areas have certain criteria as follows:

* **Must be important to industry,**
* **Must be important to a broad sector of a single industry or to several industries,**
* **Must be resolvable with MSFC resources.**

With this CAR approach, MSFC felt that it could focus on a few broad, receptive targets for the transfer of some of its capabilities, notably CFC replacement technologies and information.

UAH working with NASA MSFC developed the first CAR package on another subject: the modular manufacturing process simulation for the apparel industry. Over 300 copies of that CAR package were distributed during 1992 and 1993. Only about 10% of the requestors had difficulty using the supplied software and contacted UAH for help. Most were helped by telephone and/or mail. In addition, semi-annual $1^1/_2$ day seminars were provided at modest cost for those persons who needed hands-on help. Based on its wide acceptance in industry, the modular manufacturing CAR was judged 90% successful as a stand-alone item.

The CFC package reflects the need to quickly replace CFC compounds as well as other ozone-depleting chemicals such as methyl chloroform. In this package, federal regulations on the use of CFCs and other ozone depleters are discussed. Also, details of replacement refrigerants and solvents are provided. This is, however, a difficult package to maintain because of the need to update it frequently as new products and/or processes reach the market.

The purpose of the CFC CAR document is to provide interim information which has been compiled by the Marshall Space Flight Center regarding CFC replacement, alternate processes, and other related information. These data, while incomplete at any given time, will hopefully be of use in identifying potential sources, processes, and chemical replacements. This document will be updated periodically as additional information becomes available.

Contents of the CFC CAR Package

The CFC CAR consists of a brief introduction to the CFC replacement problem with the majority of the data contained in related appendices. Contents of the appendices are as follows:

Appendix A - General references on CFC's and replacement.

Appendix B - Addresses potential replacements and sources for solvent cleaning chemicals. The information provided is not an exhaustive list and other options are available.

Appendix C - Provides information regarding industrial refrigerant replacements and procedures for handling CFC chemicals used for refrigeration purposes. Excerpts from some applicable Federal documents are provided. Again, these data are not exhaustive and much more information exists.

Appendix D - Includes information on alternate cleaning methods and processes which may be applied to replace methods previously using CFC-containing chemicals.

Appendix E - Provides preliminary information extracted from MSFC's NASA Operational Environment Team (NOET) CFC Replacement workshops.

Appendix F - Provides a listing of government agency and industrial sources for additional information, equipment, and chemical replacements.

Promotion of CAR Packages

It is not sufficient to develop a data package that is needed by a large industrial segment unless that segment can be made aware of the package so that they can request it. Fortunately, there are various means available to contact industrial groups. Many industries or major industrial segments are represented by specific industry associations. For the sewn products (apparel) industry, the principal organization is the American Apparel Manufacturers Association (AAMA). Another method to contact an industrial group is through trade journals. Often there are a number of these publications and it is desirable to select the two or three with the most circulation.

Future CAR Packages

The success of the original CAR Modular Manufacturing Simulation and CFC packages has resulted in the NASA MSFC Technology Utilization Office seeking to develop other Critical Area Response packages. One such package for **corrosion preventive coatings** is currently being compiled.

CONCLUSIONS

The idea of a widely usable, stand-alone technology transfer product is not new. Publishing companies have long tried to accomplish data transfer with technical handbooks and special commercial software packages. An early federal example is the "Fastener Design Manual", NASA Reference Publication 1228, produced by the NASA Lewis Research Center in 1990. The concept of federal "handbooks" to promote technology transfer is considered valid because these documents can be produced as soon as the need arises, which is not always the case with their commercial counterparts. Also, federal lab data is more likely to be current because it is being produced by persons who are leaders in their specific fields, as compared to commercial editors. Consequently, Marshall Space Flight Center (MSFC) will continue to develop and promote CAR packages for unmet industrial needs.

It is felt that the CFC CAR package will become more popular as its existence becomes more widely known. It has general use in industries that form metals, manufacture electronics and make foam insulation. After the initial announcement of the availability of this package, more than 200 requests from firms have been received.

The CFC Critical Area Response (CAR) data package is sponsored by NASA Marshall Space Flight Center (MSFC) and is thus **free of charge**.

Should your company or organization provide or have knowledge of additional pertinent information on CFC replacement that would be appropriate for inclusion into the CFC CAR document or should you desire to obtain a copy of the latest release, please contact the NASA MSFC Technology Utilization Office at the following address:

Marshall Space Flight Center
Technology Utilization Office
CFC Replacement CAR
Attention: Dr. Ken Fernandez, Code LA20
Huntsville, Alabama 35812

Phone: (205) 544-3825
FAX: (205) 544-3131

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The mandated elimination of CFC's, Halons, TCA, and other ozone depleting chemicals and specific hazardous materials has required changes and new developments in aerospace materials and processes. The aerospace industry has been involved for several years in providing product substitutions, redesigning entire production processes, and developing new materials that minimize or eliminate damage to the environment. These activities emphasize replacement cleaning solvents and their application verifications, compliant coatings including corrosion protection systems, and removal techniques, chemical propulsion effects on the environment, and the initiation of modifications to relevant processing and manufacturing specifications and standards.

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